Attorney Docket No. 12524

THERMAL WATER TREATMENT

CLAIMS

We claim:

1. An apparatus for providing purified water comprising:

A. a heat exchanger for exchanging heat between purified water and makeup water, having a makeup water inlet and a preheated makeup water outlet; at least one heat exchange surface between said purified water and makeup water, a treated water inlet, and at least one or more treated water outlets; and

B. a water heater tank with a tank inlet and a tank outlet, wherein said tank inlet is connected to said heat exchanger preheated makeup water outlet and said tank outlet is connected to said heat exchanger treated water inlet.

2. The apparatus according to Claim 1, wherein when there are more than one treated water outlets, at least two or more of said one or more treated water outlets are located upstream or downstream from each other respectively.

3. The apparatus according to Claim 1 comprising at least two or more treated water outlets, wherein said treated water outlets provide purified water at different temperatures.

4. The apparatus according to Claim 1, further comprising three or more treated water outlets on said heat exchanger for removing purified water at different temperatures therefrom.

5. The apparatus of Claim 1, comprising a monitoring device for sensing water temperatures at one or more locations of said apparatus.

6. The apparatus according to Claim 5, comprising a monitoring device for determining time/temperature relationships at one or more locations of said apparatus to determine if water has been purified to a predetermined amount.

7. The apparatus according to Claim 6, wherein said monitoring device provides signals perceptible by a user at one or more locations as to the status of temperature, or time/temperature conditions or relationships for purification of water at various locations on said apparatus.

8. The apparatus according to Claim 7, wherein at least one of said locations is on or in said water heater tank.

9. The apparatus according to Claim 8, wherein said monitoring device shuts off one or more treated water outlets whenever predetermined temperature, or time/temperature conditions or relationships are not met.

10. The apparatus according to Claim 9, wherein said monitoring device shuts off water flow through the purified water apparatus whenever predetermined temperature, or time/temperature conditions or relationships are not met.

11. The apparatus according to Claim 10, wherein said monitoring device reopens said water flow when said predetermined conditions are restored.

12. The apparatus according to Claim 7, wherein said monitoring device emits an audible signal perceptible by a user at one or more locations whenever predetermined temperature, or time/temperature conditions or relationships are not met.

13. The apparatus according to Claim 7, wherein said signal comprises one or more lights at one or more locations.

14. The apparatus according to Claim 7, wherein said signal comprises a digital display of one or more conditions sensed.

15. The apparatus according to Claim 1, comprising bypass means for bypassing said heat exchanger with makeup water and interrupting the flow of makeup water through said heat exchanger.

16. The apparatus according to Claim 15, wherein said bypass means comprises;

A. a valve connected to said inlet of said heat exchanger, said valve operable to stop makeup water flow to said heat exchanger and redirecting said flow of makeup water; and

B. water lines connected to one outlet of said valve for receiving redirected makeup water from said valve and redirecting said makeup water to said water heater.

17. The apparatus according to Claim 1, comprising a second tank for storage and/or heating of purified heated water.

18. The apparatus according to Claim 1, comprising a brush-type diffuser at the outlet of said dip tube to reduce the velocity of the makeup water and maintain temperature stratification within said water heater tank.

19. The apparatus according to Claim 1, comprising a flexible cone diffuser at the outlet of said dip tube to reduce the velocity of the makeup water and maintain temperature stratification within said water heater tank.

20. The apparatus according to Claim 1, comprising at least one baffle in said water heater tank for reducing mixing of hot water in the upper portion of said water heater tank with cooler water in the lower portion of said water heater tank.

21. The apparatus according to Claim 20, wherein said at least one baffle comprises a floating baffle having a predetermined specific gravity.

22. The apparatus according to Claim 21, wherein said floating baffle comprises a plurality of floats having a predetermined specific gravity.

23. The apparatus according to Claim 22, wherein said plurality of floats comprises a plurality of spheres, ovoids, cubes or other shaped structures having a predetermined specific gravity.

24. The apparatus according to Claim 20, wherein said baffle comprises a heated baffle system.

25. The apparatus according to Claim 20, wherein said baffle comprises a heated baffle.

26. The apparatus of Claim 1 wherein said water heater tank is heated by heating means utilizing an energy source selected from the list consisting of natural gas, propane, butane, fuel oil, electricity, steam, and heat from a heat pump.

27. A method for purifying water comprising:

A. flowing makeup water into an inlet of a heat exchanger having an inlet and an outlet for preheated makeup water, and an inlet and one or more treated water outlets in a purified water section of said heat exchanger, and preheating said makeup water;

B. flowing said preheated makeup water into a water heater tank;

C. heating said preheated makeup water to a predetermined elevated temperature;

D. holding said heated water at a selected temperature in a portion of said tank so as not to mix with said preheated makeup water for a time sufficient to purify said heated water;

E. flowing said purified water into said inlet of said purified water section of said heat exchanger and cooling said water as it flows through said heat exchanger; and

F. withdrawing water through one or more treated water outlets of said purified water section of said heat exchanger.

28. The method according to Claim 27, wherein the purified water withdrawn at the different treated water outlets of said purified section is at different temperatures.

29. The method according to Claim 27, wherein said heat exchanger is a counter-flow heat exchanger.

30. A method for purifying a water distribution system comprising:

A. providing a water purification system according to Claim 15;

B. shutting off the flow of makeup water to said heat exchanger;

C. bypassing said heat exchanger and flowing makeup water into the inlet of said water heater; and

D. withdrawing hot purified water from the treated water outlets of said heat exchanger, and flowing said water to selected fixtures to purify water distribution lines and fixtures attached to said treated water outlets, until all have been turned on for a sufficient time to purify said plumbing water lines and fixtures leading from said outlets.

31. The method according to Claim 30, wherein said fixtures are turned on for a selected period of time, the water flow is stopped after the temperature of water flowing from the fixture does not change for a second selected

period of time, and the fixture and lines allowed to purify at elevated temperature for a third selected period of time sufficient to provide a thermal dose for inactivating at least a predetermined percent of selected organisms in water distribution lines of said fixtures.

32. The method according to Claim 31, wherein said fixtures are tested for temperature after said third selected period of time and the step of Claim 31 is repeated until a thermal dose sufficient to inactivate the selected organisms is obtained

33. The method according to Claim 31, wherein said first selected time is at least 1 minute, said second selected time is at least 15 seconds, and said third selected time is at least 5 minutes.

34. The method according to Claim 30, wherein said fixtures are turned on to flow at least 0.5 gpm (1.9 Lpm) liters per minute, until the temperature of water flowing from the fixture does not change for a first selected period of time, the fixture is closed and the lines allowed to purify at elevated temperature for a second selected period of time sufficient to provide a thermal dose for inactivating at least a predetermined percent of selected organisms in water distribution lines of said fixture.

35. The method according to Claim 31, wherein said fixtures are tested for temperature after said second selected period of time and the step of Claim 31 is repeated until a thermal dose sufficient to inactivate the selected organisms is obtained.

36. The method according to Claim 31, wherein said first selected time is at least is at least 15 seconds, and said second selected time is at least 15 seconds, and said third selected time is at least 3 minutes.

37. The method according to Claim 30, wherein said fixtures are turned on for a time sufficient to provide a thermal dose for inactivating at least 1% to 99.9999% of selected organisms in said plumbing water lines and fixtures.

38. The method according to Claim 30, wherein said fixtures are turned on for a time sufficient to provide a thermal dose for inactivating at least 99.9% of selected organisms in said plumbing water lines and fixtures.

39. The method according to Claim 30, wherein said fixtures are turned on for a time sufficient to provide a thermal dose for inactivating at least 99.99% of selected organisms in said plumbing water lines and fixtures.

40. The method according to Claim 30, wherein said purified water is heated above 140°F (60°C).

41. The method according to Claim 30, wherein said purified water is heated above 150°F (66°C).

42. The method according to Claim 30, wherein said purified water is heated above 160°F (71°C).

43. The method according to Claim 30, wherein said purified water is heated to between 140°F (60°C) and 210°F (99°C).

44. The method according to Claim 30, wherein said purified water is heated up to its saturation temperature.

45. The method according to Claim 30, wherein said makeup water is obtained from a source of potable water.

46. The method according to Claim 45, wherein said makeup water is obtained from a source of potable water selected from the group consisting of

a municipal water system, an industrial water supply system, good quality well water, and cisterns having clean collected rain water.

47. The method according to Claim 30, wherein said makeup water is obtained from a source of non-potable water.

48. A water purifier comprising:

A. a heat exchanger for exchanging heat between purified water and makeup water, and having a makeup water inlet and a preheated makeup water outlet; and a hot treated water inlet and at least one outlet for withdrawing treated water at a reduced temperature;

B. a water heater with an inlet and an outlet, wherein said water heater inlet is connected to said heat exchanger preheated makeup water outlet and said water heater outlet is connected to said heat exchanger hot treated water inlet; and

C. at least one mixing valve with an outlet and at least two inlets having a first inlet connected to one treated water outlet of said heat exchanger, for obtaining purified water at a reduced temperature therefrom, and a second inlet connected to said water heater outlet for obtaining hot purified water, wherein said mixing valve provides purified water at said mixing valve outlet at an intermediate temperature between said hot purified water and said reduced temperature purified water.

49. The water purifier according to Claim 48, wherein said heat exchanger comprises a counter-flow heat exchanger.

50. The water purifier according to Claim 48, wherein said water heater comprises a tank-type water heater.

51. The water purifier according to Claim 49, wherein said purified water is heated to between 140 F (60°C) and the saturation temperature of the water.

52. The water purifier according to Claim 51, wherein said water is heated for a time sufficient to provide a thermal dose for selected organisms.

53. The heat exchanger according to Claim 48, wherein said water purifier comprises two mixing valves, wherein the second mixing valve is connected to the same sources of hot and cold purified water as the first mixing valve.

54. A heat exchanger for a hot water purifier system comprising:
a purified water to makeup water heat exchanger for exchanging heat between purified water and makeup water, and having a makeup water inlet and a preheated makeup water outlet; and a hot treated water inlet and at least two treated outlets for withdrawing purified water at reduced temperatures; and wherein said treated water outlets provide purified water at different temperatures.

55. The heat exchanger according to Claim 54, wherein said preheated makeup water outlet of said heat exchanger is connected to an inlet of a tank-type water heater, and said hot treated water inlet is connected to an outlet of said tank-type water heater, said heat exchanger adapted to be mounted above said tank-type water heater.

56. The heat exchanger according to Claim 54, wherein said heat exchanger is adapted to be mounted above a tank-type water heater.

57. The heat exchanger according to Claim 54, wherein said heat exchanger comprises a counter-flow heat exchanger.

58. The heat exchanger according to Claim 54, wherein said heat exchanger is adapted to be mounted on a wall, ceiling or floor near said tank-type water heater.

59. The heat exchanger according to Claim 54, wherein said preheated makeup water outlet of said heat exchanger is connected to an inlet of a tank-type water heater, and said hot treated water inlet is connected to an outlet of said tank-type water heater, said heat exchanger adapted to be mounted around said tank-type water heater and encased in a layer of foam insulation.

60. A method of retrofitting an existing tank-type water heater for use as a water purification system comprising:

A. providing a heat exchanger according to Claim 54;

B. operatively connecting said heat exchanger with said existing tank-type water heater.

61. The method according to Claim 60, further comprising:

C. adding a flow diffuser to an inlet dip tube of said tank-type water heater by deploying said flow diffuser through said inlet dip tube.

62. The method according to Claim 60, further comprising:

C. adding a floating baffle to said tank-type water heater by deploying said floating baffle through the inside of said inlet dip tube.

63. A method for providing stratification control in a hot water tank, comprising:

A. providing a hot water heater;

B. providing a plurality of mix-impeding elements, said mix-impeding elements having one or more specific gravities corresponding to one or more desired water temperatures, and said mix-impeding

elements movable within said hot water heater to adjust to said one or more desired temperatures; and

C. impeding the mixing of water above said plurality of mix-impeding elements and water below said mix-impeding elements as the level of said one or more desired temperatures in said hot water tank varies.

64. The method of Claim 63, wherein said hot water tank is a water heater tank.

65. A method for increasing the effective output capacity of a hot water tank, comprising:

A. providing a hot water tank having a first output capacity for heating water, and having a heated water outlet for heated water of at least one desired temperature and tank inlet;

B. adding a heat exchanger and flowing makeup water into said heat exchanger thereby pre-heating said makeup water and flowing said pre-heated makeup water to said tank inlet;

C. introducing said pre-heated makeup water at an elevated temperature to said hot water tank; and

D. using the introduced preheated makeup water to increase the effective output capacity of said hot water tank, thereby enabling said water tank to effectively deliver a second output capacity of hot water which is greater than a first output capacity without said heat exchanger.

66. The method of Claim 65, wherein said output capacities are determined by the first-hour rating method.

67. The method of Claim 65, wherein said step of adding said heat exchanger includes pre-heating by exchanging heat between a portion of water exiting said tank outlet and the water entering said tank inlet.

68. The method of Claim 65, wherein said hot water tank further comprises:

E. means for providing stratification control in said hot water tank, comprising at least one mix-impeding element impeding the mixing of water above said plurality of mix-impeding elements and water below said plurality of mix-impeding elements as the level of one or more desired temperatures in said hot water tank varies; and thereby maintaining the volume of heated water above said plurality of mix-impeding elements at a desired temperature for delivery at said heated water outlet.

69. A method for increasing the effective output capacity of a hot water tank, comprising:

A. providing a hot water tank having a first output capacity for delivering heated water, a heated water outlet for heated water for at least one desired temperature and a tank inlet;

B. introducing makeup water at a second, lower temperature to said hot water tank at said tank inlet;

C. providing stratification control in said hot water tank, comprising a plurality of mix-impeding elements at one or more specific gravities impeding the mixing of water above said plurality of mix-impeding elements and water below said plurality of mix-impeding elements as the level of one or more desired temperatures in said hot water tank varies;

D. maintaining the volume of heated water above said plurality of mix-impeding elements at said one or more desired temperatures for delivery at said tank outlet; and

E. using said plurality of mix-impeding elements for heating water to more effectively increase the temperature of makeup water to the desired temperature of said heated water, thereby increasing the effective output capacity of said hot water tank.

70. The method of Claim 69, wherein said increased effective output capacity is determined by the first-hour rating method.

71. A diffuser for introducing a fluid to a tank, comprising:

A. a support;

B. a plurality of brush bristles mounted to said support; wherein said apparatus slows the flow of incoming water to said tank.

72. The diffuser according to Claim 71, wherein said brush bristles are mounted substantially radially to said support.

73. The diffuser according to Claim 71, wherein said support includes a mount at a top portion thereof for fastening said apparatus to the inlet dip tube of said tank.

74. The diffuser according to Claim 71, wherein said bristles are arranged in layers, wherein each layer is in spaced relationship from one layer to the next.

75. The diffuser according to Claim 71, wherein said apparatus has between two and 20 layers of bristles, and each layer has between four and 20 bristles.

76. The diffuser according to Claim 71, wherein said bristles are arranged to increase in length from the top to the bottom of said support.

77. The diffuser according to Claim 71, wherein said bristles vary in length between ½ inch and six inches.

78. A diffuser for introducing a fluid to a tank, comprising:

A. a support;

B. a plurality of screens mounted to said support; wherein said diffuser slows the flow of incoming water to said tank.

79. The diffuser according to Claim 78, wherein said support includes a mounting at a top portion thereof for fastening said apparatus to the inlet dip tube of said tank.

80. The diffuser according to Claim 78, wherein said screens are arranged in layers, each layer in spaced relationship from one layer to the next.

81. The diffuser according to Claim 78, wherein said diffuser has between two to 20 layers of screens.

82. A diffuser for introducing a fluid to a tank, comprising:
A. a flexible cone with a small diameter opening at the apex end and a large diameter opening at the base; and
B. a mounting at said apex end for fastening said flexible cone to the inlet dip tube of said tank; wherein said flexible cone slows the flow of incoming water to said tank.

83. A diffuser according to Claim 82, wherein said flexible cone has an angle of spread of about 7° to about 30°.

84. A diffuser according to Claim 83, wherein said flexible cone has an angle of spread of about 7° to about 15°.

85. A diffuser for introducing water to a tank, comprising:
a porous network having sufficient porosity to receive and discharge at least 2.5 gpm (9.5 Lpm) of water entering said tank, and slow the velocity of said entering water.

86. A thermal ballast-water treatment system for a ship comprising:

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A. a heat treatment system as disclosed in the specification herein for heat treating incoming, outgoing ballast, and/or stored ballast water;

B. a ballast tank connected to said heat treatment system for storing treated water or water to be treated; and

C. a pump connected to said heat treatment system and/or tank.

87. The thermal ballast-water treatment system for a ship according to Claim 86, wherein said heat treatment system comprises a heat exchanger.

88. The thermal ballast-water treatment system for a ship according to Claim 87, wherein said heat treatment system comprises a heat exchanger and a water heater tank.

89. A method for thermally treating ship ballast water comprising:

A. pumping water from a ship's surroundings or from a ship's interior to a heat treatment system;

B. treating said water with heat to provide a thermal dose sufficient to inactivate a selected percent of selected organisms present in said water; and

C. pumping said treated water to a ballast tank on said ship.

90. A method for thermally treating ship ballast water comprising:

A. pumping water from a ship's surroundings or from a ship's interior to a tank on a ship;

B. holding said water in said tank for one day or more;

C. pumping said held water to a heat treatment system and treating said water with heat to provide a thermal dose sufficient to inactivate a selected percent of selected organisms present in said water; and

D. discharging said treated water to the environment.

91. A method for thermally treating ship ballast water comprising:

A. pumping water from a ship's surroundings or from a ship's interior to a heat treatment system;

B. treating said water with heat to provide a thermal dose sufficient to inactivate a selected percent of selected organisms present in said water;

C. pumping said treated water to a tank on said ship and holding said water in said tank;

D. pumping said held water to said heat treatment system;

E. treating the water in said heat treatment system for a second time with heat to provide a thermal dose sufficient to inactivate a selected percent of selected organisms present in the held water; and

F. pumping said second heat-treated water outside the ship.

92. An apparatus for providing treated water comprising:

A. a heat exchanger having a first section and a second section located upstream from said first section for exchanging heat, wherein said first section exchanges heat between water from an auxiliary heater and makeup water, and said second section exchanges heat between water from an auxiliary heater to water from a water tank, said heat exchanger first section having a makeup water inlet and a preheated makeup water outlet; at least one heat exchange surface in said first section between said water from said auxiliary heater and makeup water, said heat exchanger second section having at least one surface between said water from said auxiliary heater and said water from said water tank, said second heat exchanger section having an inlet for water from said auxiliary heater water and an outlet for water to said auxiliary water heater, an inlet for water from said water tank, and said first section having at least one or more treated water outlets;

B. a water heater tank with a tank inlet and a tank outlet, wherein said tank inlet is connected to receive water from said first section heat exchanger preheated makeup water outlet and said tank outlet is connected to deliver water to a second section inlet for water from said water tank; and

C. an auxiliary heater having an inlet connected to an outlet from said second section of said heat exchanger for receiving water from said water tank that has been preheated in said second heat exchanger section, and said auxiliary heater having an outlet connected to said inlet on said second section heat exchanger for water from said auxiliary heater.

93. An apparatus for providing treated water comprising:

A. a heat exchanger for exchanging heat between treated water and makeup water, having a makeup water inlet and a preheated makeup water outlet; at least one heat exchange surface between said treated water and makeup water, a treated water inlet, and at least one or more treated water outlets; and

B. a water heater tank with a tank inlet and a tank outlet, wherein said tank inlet is connected to said heat exchanger preheated makeup water outlet and said tank outlet is connected to said heat exchanger treated water inlet.

94. The apparatus according to Claim 93, wherein when there are more than one treated water outlets, at least two or more of said more than one treated water outlets are located upstream or downstream from each other respectively.

95. The apparatus according to Claim 93 comprising at least two or more treated water outlets, wherein said treated water outlets provide water at different temperatures.

96. The apparatus according to Claim 93, comprising bypass means for bypassing said heat exchanger with makeup water and interrupting the flow of makeup water through said heat exchanger.

97. The apparatus according to Claim 93, wherein said bypass means comprises;

A. a valve connected to said inlet of said heat exchanger, said valve operable to stop makeup water flow to said head exchanger and redirecting said flow of makeup water; and

B. water lines connected to one outlet of said valve for receiving redirected makeup water from said valve and redirecting said makeup water to said water heater.

98. A method for treating water comprising:

A. flowing makeup water into an inlet of a heat exchanger having an inlet and an outlet for preheated makeup water, and an inlet and one or more treated water outlets in a treated water section of said heat exchanger and preheating said makeup water;

B. flowing said preheated makeup water to a water heater tank;

C. heating said preheated makeup water to a predetermined elevated temperature;

D. holding said heated water above a selected temperature in a portion of said tank so as not to mix with said preheated makeup water for a time sufficient to treat said heated water;

E. flowing said treated water into said inlet of said treated water section of said heat exchanger and cooling said water as it flows through said heat exchanger; and

F. withdrawing water through one or more treated water outlets of said treated water section.

99. A water treating system comprising:

A. a heat exchanger for exchanging heat between treated water and makeup water, and having a makeup water inlet and a preheated makeup water outlet; and a hot treated water inlet and at least one outlet for withdrawing treated water at a reduced temperature;

B. a water heater with an inlet and an outlet, wherein said water heater inlet is connected to said heat exchanger preheated makeup water outlet and said water heater outlet is connected to said heat exchanger hot treated water inlet; and

C. at least one mixing valve with an outlet and at least two inlets having a first inlet connected to one treated water outlet of said heat exchanger, for obtaining treated water at a reduced temperature therefrom, and a second inlet connected to said water heater outlet for obtaining hot treated water, wherein said mixing valve provides treated water at said mixing valve outlet at an intermediate temperature between said hot treated water and said reduced temperature treated water.

100. The water treating system according to Claim 99, wherein said heat exchanger comprises a counter-flow heat exchanger.

101. The water treating system according to Claim 99, wherein said water heater comprises a tank-type water heater.

102. A heat exchanger for a hot water treating system, comprising:

a treated water to makeup water heat exchanger for exchanging heat between treated water and makeup water, and having a makeup water inlet and a preheated makeup water outlet; and a hot treated water inlet and at least two treated outlets for withdrawing treated water at reduced temperatures; and wherein said treated water outlets provide treated water at different temperatures.

103. The heat exchanger according to Claim 102, wherein said preheated makeup water outlet of said heat exchanger is connected to the inlet of a tank-type water heater, said heat exchanger adapted to be mounted above said tank-type water heater.

104. The heat exchanger according to Claim 102, wherein said heat exchanger is adapted to be mounted above a tank-type water heater.

105. A purification control system for a plumbing system comprising:

A. a heat exchanger having an inlet and an outlet for makeup water, and an inlet for hot water and at least one outlet water at reduced temperature;

B. a three way valve for controlling water flow from said at least one outlet at reduced temperature having an inlet for water from said at least one outlet at reduced temperature from heat exchanger, a valve outlet; and a second valve inlet; and

C. water lines for flowing hot water from a source of hot purified water to said second valve inlet of said three-way valve.

106. A purification control system according to Claim 105, comprising at least two outlets for supplying water at reduced temperature from said heat exchanger.